A FIELD EVALUATION OF POLYPROPYLENE FIBERS IN LATEX MODIFIED SHOTCRETE

by:

R. M. ROLLINGS

MINISTRY OF TRANSPORTATION OF ONTARIO
ENGINEERING MATERIALS OFFICE
CONCRETE SECTION
SEPTEMBER 1988

ISBN - O - 7729 - 4450 - 4

SUMMARY

A limited field trial was carried out to evaluate the effect of polypropylene fibers on the properties of latex modified shotcrete.

The addition of the fibers created no noticeable difference in the ease of application or in the amount of rebound.

The fibers had no significant effect on any of the tested properties of the shotcrete.

No shrinkage cracks were evident in the shotcrete with or without fibers.

TABLE OF CONTENTS

		PAGE
1.	INTRODUCTION	1
2.	FIBER DESCRIPTION	1
3.	MIX DESIGN	1
4.	SITE DESCRIPTION	2
5.	CONSTRUCTION	2
6.	OBSERVATIONS	3
7.	TESTING	4
8.	DISCUSSION	5
9.	CONCLUSIONS	5

TABLE 1: TEST RESULTS 4

FIGURE 1: DRY MIX SHOTCRETE EQUIPMENT 2
FIGURE 2: FINAL LIFT OF LATEX MODIFIED SHOTECRETE 3

1. INTRODUCTION

Latex modified shotcrete is commonly used to repair bridge substructures that have scaled, spalled and/or delaminated areas. Generally, the performance of the shotcrete is adequate, however, shrinkage cracking often occurs.

Fibrillated polypropylene fibers, manufactured by Fibermesh Inc., Chattanooga, Tennessee, were supplied by Anthes Equipment Ltd. of Mississauga, Ontario. It is claimed that addition of these fibers to shotcrete will significantly reduce shrinkage cracking and permeability with no adverse effects on other properties.

To determine the validity of these claims and examine the potential benefits of polypropylene fibers, a limited field trial was carried out. A small section (approximately 10 m3 in area) on a bridge pier was repaired using latex modified shotcrete with fiber added and the adjacent section was done without fibers.

2. FIBER DESCRIPTION

The polypropylene fibers are produced as fibrillated bundles, which upon mixing open and separate into individual fibers. The manufacturer's specification details the following properties:

Specific Gravity	0.91
Ultimate Elongation	15%
Young's Modulus	3.5 kn/mm2
Tensile Strength	.56 - .77 kn/mm2
Ignition Temperature	590 °C
Thermal Conductivity	Low
Electrical Conductivity	Low

3. MIX DESIGN

The contractor's mix design for the latex modified shotcrete was as follows:

-4.5 parts fine aggregate
-1 part cement
-1 part latex to 3 parts cement
-water/cement ratio .35

The fibers, 13 mm in length, were added to the mix at a dosage of 0.9 kg/m3.

4. SITE DESCRIPTION

The trial took place as part of Contract 86-96 on the eastbound Otonabee River bridge (site no.26-458-61), Highway 7 near Peterborough. The sections were done on the west face of the first pier east of the Otonabee River. This pier required repair work due to delaminations caused by a finger plate expansion joint overhead. The depth of removal was 100 to 150 mm.

5. CONSTRUCTION

The shotcrete contractor was Underground Sevices Ltd. The dry mix process (see Figure 1) was used, with the sand and cement mixed together in a .15 m3 (5 ft3) batch, conveyed to a hopper and shot through the hose to the nozzle. The nozzleman controlled the consistency of the mixture.

The fibers were pre-measured and added by hand to the batch during the mixing.

The first lift of fiber modified shotcrete was shot on July 13, 1987, however, operations had to be suspended due to rain. The final lift was completed on July 15, 1987 along with the adjacent section of shotcrete without fibers (see Figure 2).

Both sections were reinforced with wire mesh tied onto the existing reinforcing steel.

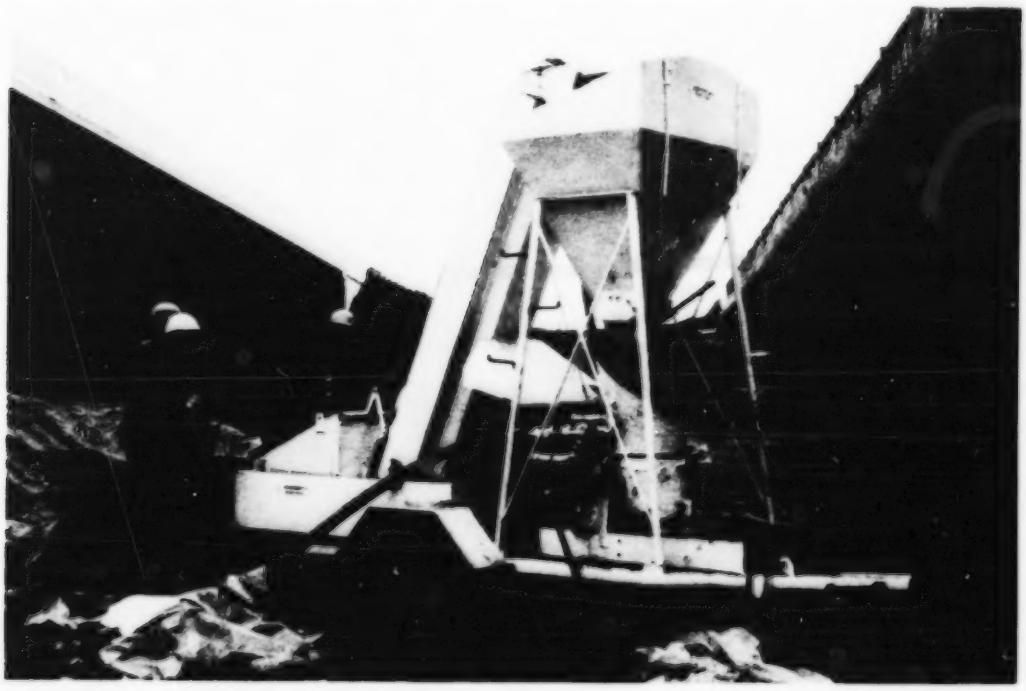

Figure 1: Dry Mix Shotecrete Equipment

No Fibers With Fibers

Figure 2: Final Lift of Fiber Modified Shotecrete

6. OBSERVATIONS

1. Although crude, adding the fibers by hand posed no problems. A more elaborate method could be developed if extensive use of fibers is considered.

2. The bundled fibers appeared to separate and dispersed uniformly throughout the mix.

3. There seemed to be no difference in the appearance or amount of rebound between fiber and non-fiber shotcrete application. The fibers could be seen sticking out of the mix from close up.

4. The nozzleman stated that there was little or no difference in how the mixes behaved during shooting.

7. TESTING

On July 27 and July 28, 1987, twelve cores (100 mm in diameter) were taken, seven containing the fibers and five without. Each of the two types were tested for density, absorption, compressive strength, chloride permeability and bond strength. The test results and procedures are shown in Table I.

TABLE 1: TEST RESULTS

TEST	FIBERS		NO FIBERS	
	RESULTS	MEAN	RESULTS	MEAN
SSD Density, Kg/M3	2280.3	-	2283.4	-
Water Absorption (48 h) % by Mass (ASTM C 642-82)	4.99	-	3.74	-
Compressive Strength, MPa (MTO LS-407)	33.3 27.1	30.2	29.9 35.9	32.9
Rapid Chloride Permeability, Coulombs (AASHTO T 277-83i)	937 2237	1587	1967 3130	2549
Bond Strength, MPa	1.37 *0.64	1.01	1.44	-

- Not applicable
* Core had a sliver of reinforcing steel at the break which probably contributed to the low result

8. DISCUSSION

The addition of fibers to the shotcrete seemed to have little effect on density, absorption or bond strength. The chloride permeability of the fiber shotcrete appears to be lower. The large range of permeability results may, however, indicate variability in the amount of latex present rather than the effect of the fibers. The compressive strength of the cores containing fibers is slightly reduced (approximately 8%).

A site visit in the spring of 1988 confirmed that none of the shotcrete (with or without fibers) showed any signs of shrinkage cracking.

9. CONCLUSIONS

1. The addition of polypropylene fibers to latex modified shotcrete had no significant effects on its properties.

2. Additional trials should be delayed until Research and Development Branch has completed their evaluation of shotcrete.